



U.S. Department of Energy

Office of Electricity Delivery and Energy Reliability

U.S. DOE Microgrid Initiative Overview

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Defining Microgrids

Microgrid Definition

A microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that acts as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode.

Key Attributes

1. Grouping interconnected loads and distributed energy resources
2. Can operate in both island mode or grid-connected
3. Can connect and disconnect from the grid
4. Acts as a single controllable entity to the grid



Enhancing Security and Reliability Through the Use of Microgrids

DOE's Goal: lead national efforts to modernize the electric grid, enhance security and reliability of the energy infrastructure, and facilitate recovery from disruptions to energy supply.

<i>Grid Modernization</i>	
Attributes	DOE Goals
Energy Efficiency	Increase efficiency of the electric delivery system through reduced energy losses.
System Efficiency	Reduce peak price and price volatility of electricity, increased asset utilization and provide accessibility to a variety of fuel sources.
Reliability	Strengthen grid stability and reduce the frequency and duration of operational disturbances.
Security	The energy infrastructure is hardened to detect, prevent and mitigate external disruptions to the energy sector.

Microgrid Enhanced Distribution

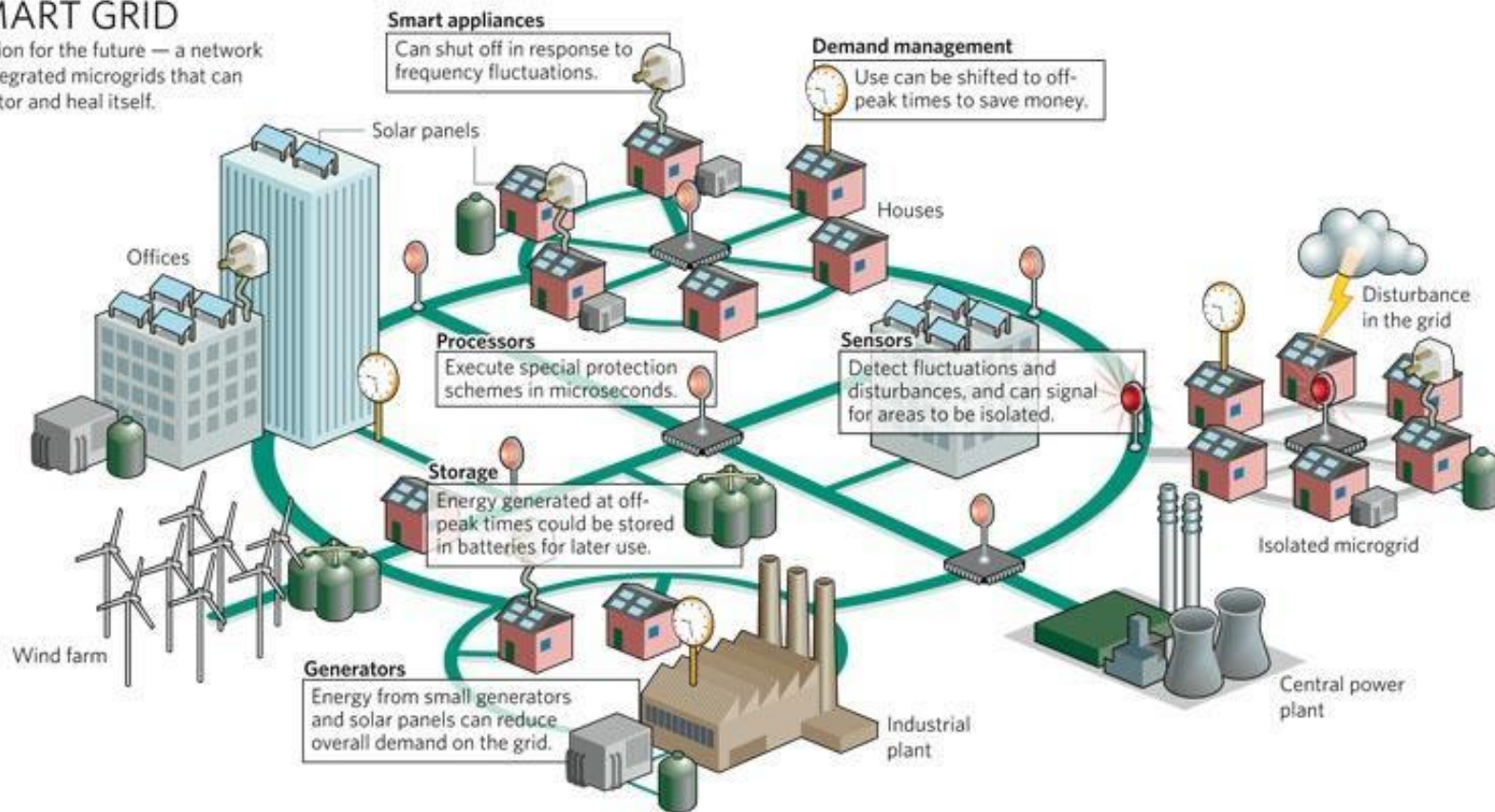
- Ease of CHP application
- Supports increase of renewables—firms intermittent resources
- Arbitrage of energy price differentials
- Enhance G&T by use of plug-and-play DER for peak shaving
- Enhance reliability with international islanding
- High local reliability
- Energy during outages



U.S. Vision: Grid Modernization

SMART GRID

A vision for the future — a network of integrated microgrids that can monitor and heal itself.



Picture courtesy of: Smart Grid 2030

Microgrid RD&D

To date, the bulk of work has been on microgrid demonstrations

FY 2013 and prior

- Renewable and Distributed Systems Integration
- Consortium for Electric Reliability Technology Solutions (CERTS)
- The Distributed Energy Resources Customer Adoption Model (DER-CAM)
- Energy Surety Microgrids
- Smart Power Infrastructure Demonstration for Energy, Reliability, and Security (SPIDERS)
- Standards Development – Interconnection and Interoperability

FY 2013 and beyond

- RD&D to reach 2020 microgrid performance targets* on costs, reliability, system energy efficiencies, and emissions

*Develop microgrid systems capable of reducing outage time of required loads by >98% ; cost comparable to non- integrated baseline solutions (UPS + diesel genset); reduce emissions by >20%; improve system energy efficiencies by >20%



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Microgrid R&D in FY15

Supporting achievement of:

- DOE program targets in reliability, system efficiency, emissions reduction, and cost effectiveness
- Community-defined resiliency objectives

National Lab Activities

- **Microgrid Design Toolset (MDT):** Decision-support tool for designers and planners to meet objectives and constraints, SNL/LBNL/PNNL
- **Microgrid Controllers:** Controllers for integration with operation centers to have microgrids participate in utility operation and energy market activities, ORNL/LBNL w. UW-Madison
- **Microgrid Test Bed:** For system-level testing and test plan development, ORNL/LANL
- **Microgrid as a Resilience Resource:** Support of distribution system restoration strategies, PNNL/WSU
- **Design Tool for Remote Off-grid Microgrids (AC and DC):** through a lab opportunity announcement
- **Scoping Study:** Networked microgrids, multinational labs.

Industry Activities

- **7 public/private partnerships,** through FY 2014 FOA, on development and feasibility testing of microgrid system designs equipped with microgrid controllers
- **State/regional partnerships**



DOE Awards \$8 Million for Microgrids

- On September 8, 2014, in support of President Obama's Climate Action Plan and the Administration's commitment to improve national power grid resiliency, the Department of Energy announced more than \$8 million for 7 microgrid projects to help cities and towns better prepare for extreme weather events and other potential electricity disruptions
- Each project received approximately \$1.2 million and also includes a company cost share ranging from 20 percent to about 50 percent

DOE 2014 Microgrid Projects (1)

- **ALSTOM Grid, Inc.**

Located in Redmond, Washington, ALSTOM Grid will research and design community microgrid systems for the Philadelphia Industrial Development Corporation and the Philadelphia Water Department

- **Burr Energy, LLC**

Headquartered in Little Falls, Minnesota, Burr Energy will design and build a resilient microgrid to allow the Olney, Maryland Town Center to function normally as a “lights-on” district for weeks in the event of a regional outage. A second microgrid will be designed for multi-use commercial development in nearby Prince George’s County, Maryland.

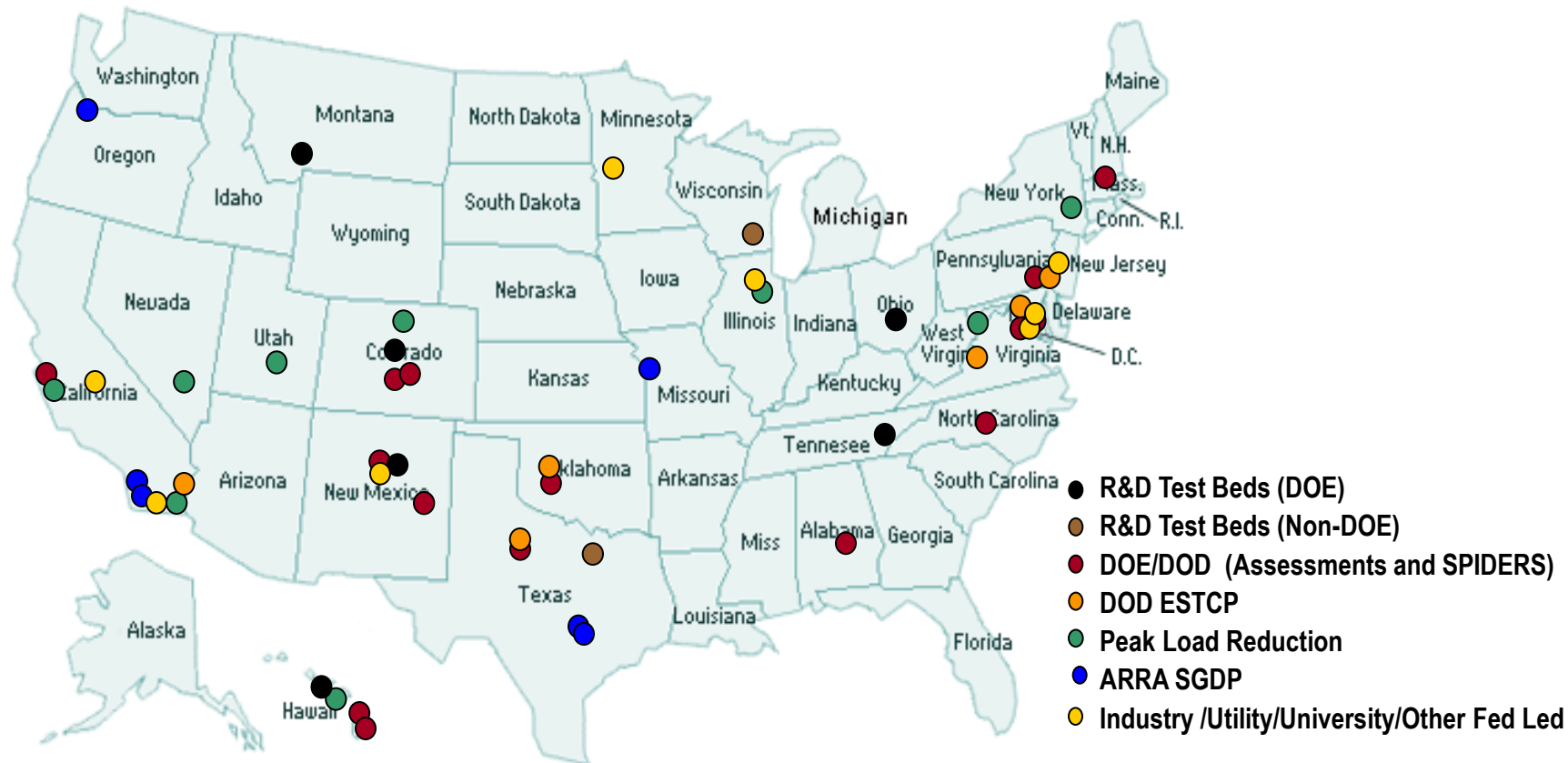
- **Commonwealth Edison Company (ComEd)**

Headquartered in Chicago, ComEd will develop and test a commercial-grade microgrid controller capable of controlling a system of two or more interconnected microgrids.

DOE 2014 Microgrid Projects (2)

- **Electric Power Research Institute (EPRI)**
Located in Knoxville, Tennessee, EPRI will develop a commercially-viable standardized microgrid controller that can allow a community to provide continuous power for critical loads.
- **General Electric Company (GE)**
Based in Niskayuna, New York, GE Global Research will develop an enhanced microgrid control system by adding new capabilities, such as frequency regulation.
- **TDX Power, Inc.**
Headquartered in Anchorage, Alaska, TDX will engineer, design, simulate, and build a microgrid control system on Saint Paul Island, an island located in the Bering Sea hundreds of miles from mainland Alaska.
- **The University of California, Irvine (UCI)**
The Advanced Power and Energy Program at UCI will develop and test a generic microgrid controller intended to be readily adapted to manage a range of microgrid systems

Current Microgrid Landscape



Federal programs, institutions, and the private sector are increasing microgrid development and deployment. The number of successfully deployed microgrids will verify the benefits and decrease implementation risks further expanding the market for microgrids.

Commercial Application of a CERTS Microgrid at Santa Rita Jail

When a disturbance to the utility grid occurs, the automatic disconnect switch enables the facility to “island” itself from the main utility grid and independently generate and store its own energy.

Utility power enters the facility at the “Point of Common Coupling”

PG&E utility interconnection or “Point of Common Coupling” and static disconnect switch



Two 1.2 MW backup diesel generators



Distributed Energy Resources Management System (DERMS)



The distributed energy resources management system (DERMS) serves to reduce peak demand during normal grid-connected operation or during a demand response event.

1 MW fuel cell



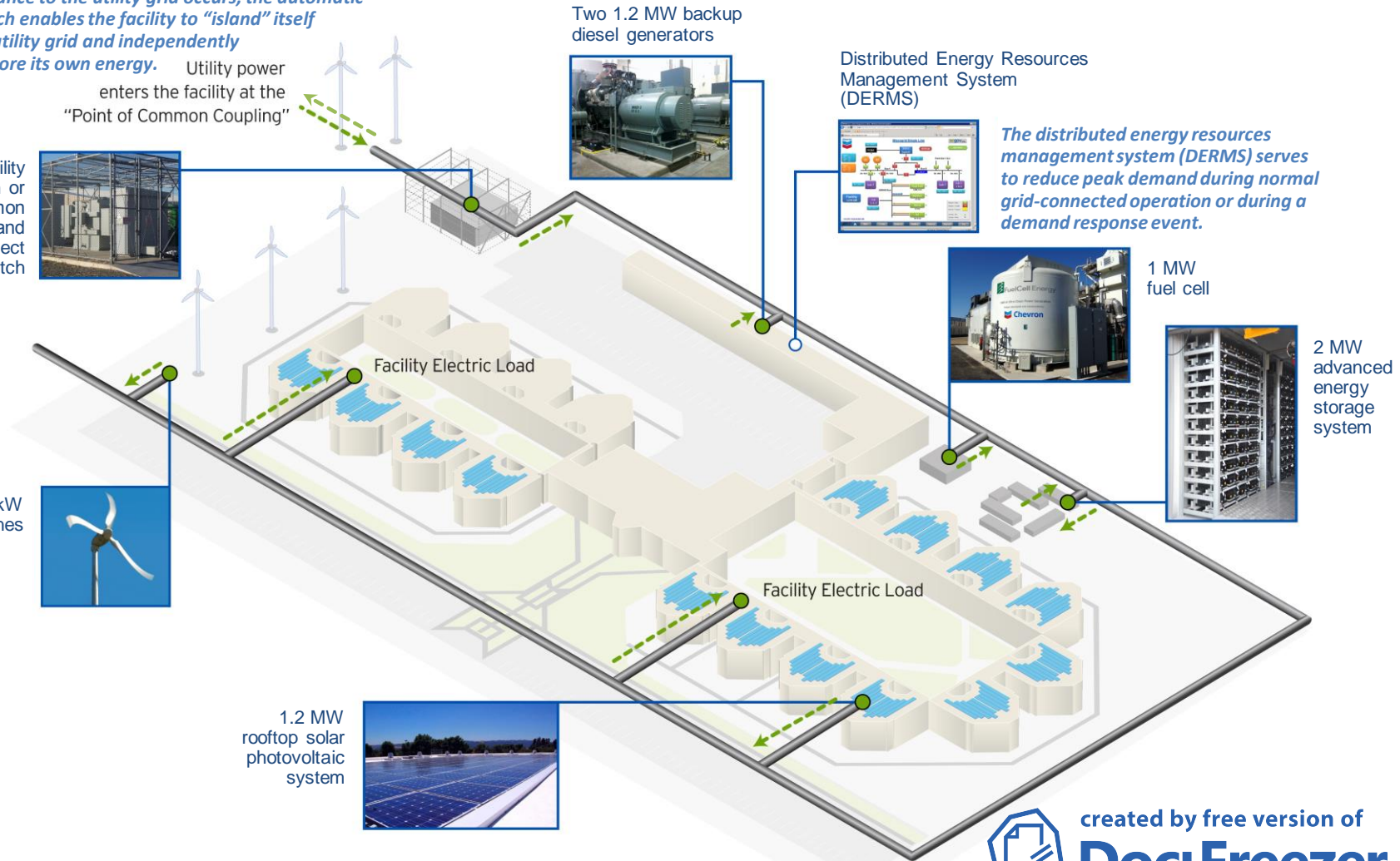
2 MW advanced energy storage system



Five 2.3 kW wind turbines



1.2 MW rooftop solar photovoltaic system



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Commercial Application at the White Oak Federal Center in Maryland*

- 55 MW of generation (gas turbines, steam turbines, IC engine, back start diesel generator)
- 25 KW fixed and 5 KW tracking PV arrays
- Absorption chillers and waste heat boilers
- 2 million gal. of chilled water thermal storage



*http://mn.gov/puc/documents/pdf_files/014402.pdf



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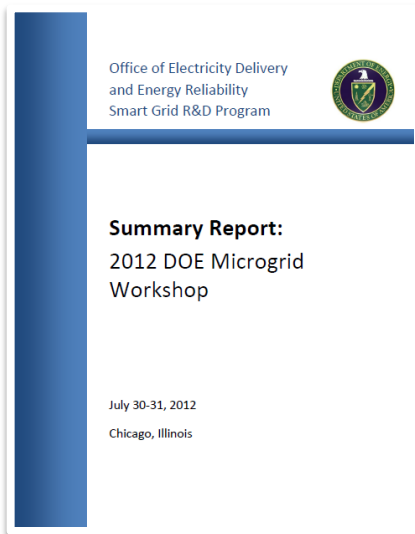
National Lab R&D Addressing DOE 2020 Microgrid Performance Targets

Workshops to engage stakeholders for R&D planning

- 2011 workshop affirmed DOE 2020 targets and defined R&D areas for component and system integration technologies
- 2012 workshop integrated R&D areas (from 2011) into Planning/Design and Operations/Control and prioritized R&D topics in each

National lab R&D focusing on addressing priorities of workshop findings

- Use case development to define performance requirements and technology specifications
- Cost and benefit analysis to ID high-impact R&D for investments
- Standardized design tools for decision-support analysis
- Integrated controller with μ SCADA/ μ EMS functionalities



Workshop report available at
<http://energy.gov/oe/articles/2012-microgrid-workshop-summary-released>



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Microgrids: Supporting Communities in Preparing for Climate Impacts

Short-term

- Partner with States (CT, NY, NJ) to deploy microgrids for rebuilding electric infrastructure by providing technical assistance and advanced R&D products
- Examples: partnerships with NJ on a stronger and more resilient transit system (TRANSITGRID) and on rebuilding electric grid in the Hoboken region, in the aftermath of Hurricane Sandy

Mid-term

- Expand multi-state and regional partnerships to promote microgrids for enhanced recovery and resilience of electric grid

Long-term

- Fully integrate a network of microgrids at customer sites and varying scales (feeders, substations) to support achieving a self healing distribution and transmission system



Microgrids: Supporting Grid Reliability and Resilience

Reduced incidents of outages

- Microgrids will provide energy surety to critical loads and will reduce outages for other loads

Enhanced reliability

- Microgrids will support faster restoration during power disturbances that cost American businesses (and all of us) billions

Reduced vulnerability

- Microgrids will enhance resiliency of electric power system against both cyber and physical threats



Microgrid Resources

- Office of Electricity Delivery and Energy Reliability
<http://energy.gov/oe/services/technology-development/smart-grid/role-microgrids-helping-advance-nation-s-energy-system>
- Smart Grid
<http://www.smartgrid.gov>
- Sandia National Laboratory - Advanced Microgrids
http://nyssmartgrid.com/wp-content/uploads/The-Advanced-Microgrid_Integration-and-Interoperability-Final.pdf
- Berkley Lab (DER-CAM and International Symposium)
<http://der.lbl.gov/>
- Microgrid workshop results
<http://www.e2rg.com/reports>

Contact Information

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Smart Grid: smartgrid.gov